APPARATUS FOR PRODUCING WATER-IN-OIL EMULSIFIED FUEL AND SUPPLYING THE SAME

BACKGROUND OF THE INVENTION

(a) Field of the Invention

The present invention relates to an apparatus for producing emulsified fuel and supplying the same to a boiler, and more particularly, to an apparatus for producing and supplying water-in-oil emulsified fuel that supplies to a boiler water-in-oil emulsified fuel, which is emulsified by mixing an emulsifier and water in crude oil such as bunker C oil or bunker A oil.

(b) Description of the Related Art

Generally, emulsion refers to the state of uniform dispersion to a minute particle state of a liquid that is within a liquid and unmixed with the same.

In particular, water-in-oil (W/O) emulsified fuel is realized by mixing water or waste water, and a surface active agent (an emulsifier) in a high carbide, high viscosity oil such as crude oil (bunker C oil), which is a low cost, highly efficient heat source that is severely limited in use because it contributes to air pollution. Water-in-oil emulsified fuel refers also to purified oil that is completely combusted in a combustion boiler as a result of micro explosions taking place by water bubbles, and that contains an additive that minimizes the concentration of dust, smoke, SOx, NOx, CO, etc., which are the main causes of air pollution in exhaust gas, such that the resulting fuel is highly efficient and environmentally friendly.

In order to reduce the consumption of petroleum fuel such as kerosene and gasoline, and minimize NOx, smoke, and other such exhausts, there are various methods for producing and combusting emulsified fuel by mixing water and a small amount of a surface active agent with petroleum fuel.

In the prior art, in order to obtain a superior emulsified fuel by emulsifying water-in-oil, an emulsifier such as a surface active agent or another additive is mixed into the water-in-oil, and an emulsified fuel is obtained using a high-performance mixer or emulsifying apparatus. However, in the processes of storing, transporting, pre-heating, and performing burner supply, as a result of the differences in specific gravity and surface tension between the fuel oil and water, there is a breakdown in phase stability, separation between the water and oil, and fuel oil is supplied continuously in a non-uniform manner through a system of imprecise and unstable injection amount and injection ratio of water and oil. Therefore, in the combustion process, stoppage of combustion repeatedly occurs and combustion efficiency is unfavorable such that it is difficult to obtain the goal for reducing fuel oil.

SUMMARY OF THE INVENTION

The present invention has been made in an effort to solve these problems. It is an object of the present invention to provide an apparatus for producing and supplying water-in-oil emulsified fuel in which an emulsifier and water are mixed in crude oil such as bunker C oil (hereinafter 'B-C oil') or bunker A oil (hereinafter 'B-A oil') at an optimal ratio, and the resulting water-in-oil emulsified fuel is supplied to a boiler where full combustion takes place, thereby preventing contribution to air pollution and reducing energy requirements.

It is another object of the present invention to provide an apparatus for producing and supplying water-in-oil emulsified fuel in which a drive apparatus is simplified to thereby minimize areas of potential breakdown and provide for greater durability of the overall apparatus.

An apparatus for producing and supplying water-in-oil emulsified fuel according to a first embodiment includes an additive storage tank for storing an emulsifier that prevents the separation of water and oil when maintaining

water-in-oil emulsified fuel at a high temperature; an emulsion tank for storing water-in-oil emulsified fuel and supplying the same to a boiler from a center side area through a boiler supply line; a circulation electric heater mounted to one side within the emulsion tank to uniformly maintain a temperature of the supplied water-in-oil emulsified fuel; a level switch mounted to the emulsion tank to adjust a storage amount of the water-in-oil emulsified fuel, which is established to mach a usage load of the boiler; an additive supply pump connected to the additive storage tank supplying at a predetermined amount the emulsifier stored therein to allow for mixing of the emulsifier with water and B-C oil; an additive flow meter connected to the additive supply pump and controlling an operation of the same such that the emulsifier is supplied by a predetermined supply amount; a B-C oil supply pump supplying B-C oil by a predetermined amount for mixing with water and an emulsifier; a B-C oil flow meter connected to the B-C oil supply pump and controlling an operation of the same such that the B-C oil is supplied by a predetermined supply amount; a first mixer connected both to an additive supply line that is connected to the additive flow meter and to a B-C oil supply line that is connected to the B-C oil flow meter, the first mixer mixing the B-C oil and the emulsifier; a water cutoff valve supplying water by a predetermined amount for mixing with the B-C oil and the emulsifier; a water flow meter connected to the water cutoff valve and controlling an operation of the same such that water is supplied by a predetermined supply amount; a mixing ejector connected both to a water supply line, which is connected to the water flow meter, and to the first mixer, the mixing ejector primarily uniformly mixing a raw material oil of the B-C oil and the emulsifier, and discharging a resulting mixture; a mixer pump connected to the mixing ejector and a lower end of the emulsion tank for re-mixing the raw material oil supplied from the mixing ejector and the emulsified fuel supplied from the emulsion tank; and a second mixer connected to the mixer pump for remixing the primarily mixed raw material oil and the emulsified fuel to

uniformly emulsify a resulting mixture to uniform minute particles, then supplying a result to the emulsion tank through the circulation electric heater.

The additive supply pump, the B-C oil supply pump, the water cutoff valve, the additive flow meter, the B-C oil flow meter, and the water flow meter operate when a LOW signal of the level switch of the emulsion tank is transmitted, and the additive flow pump, the B-C oil supply, and the water cutoff valve, to which are connected respectively the additive flow meter, the B-C oil flow meter, and the water flow meter discontinue operation according to a discontinue signal transmitted when predetermined values of these flow meters are reached.

Further, following the supply of a predetermined amount of the raw materials, emulsified fuel mixed in a circulation system of the emulsion tank, the mixer pump, the second mixer, and the circulation electric heater is continuously circulated even if raw material supply is stopped such that emulsified fuel that is always in a uniform state is supplied while maintaining a predetermined ratio, a predetermined moisture particle state, and a predetermined temperature.

The apparatus further includes a steam coil mounted to an inner surface of the additive storage tank for maintaining the emulsifier stored therein at a predetermined temperature. Preferably, the steam coil maintains the emulsifier stored in the additive storage tank at a temperature of 60~110℃.

The apparatus further includes an electric heater mounted to a lower output side of the additive storage tank for uniformly maintaining the emulsifier exiting the additive storage tank at a predetermined temperature such that stable additive supply is ensured during initial operation. Preferably, the electric heater maintains the emulsifier stored in the additive storage tank at a temperature of 60~110℃.

Preferably, the capacity of the emulsion tank is at least two batches of a raw material supply amount.

The apparatus further includes a temperature retaining electric heater mounted to an exterior of the emulsion tank to maintain a temperature of the water-in-oil emulsified fuel stored in the emulsion tank at a predetermined level. Preferably, the temperature retaining electric heater maintains the water-in-oil emulsified fuel stored in the emulsion tank at a temperature of 60～80℃.

The circulation electric heater preferably maintains the water-in-oil emulsified fuel supplied to the emulsion tank at a temperature of 60～80℃.

Preferably, the additive supply pump supplies an emulsifier at a fixed ratio of 0.5～1% of the first batch raw material supply amount, the B-C supply pump supplies B-C oil at a fixed ratio of 69.5～89.5% of the first batch raw material supply amount, and the water cutoff valve supplies water at a fixed ratio of 10～30% of the first batch raw material supply amount.

The first mixer may be a single-type line mixer, and the second mixer may be a double-type line mixer.

The mixer pump may include a pre-mixer pump and a main mixer pump, which are connected in parallel between the emulsion tank and the second mixer.

A shell and tube heat exchanger may be used for the circulation electric heater.

An apparatus for producing and supplying water-in-oil emulsified fuel according to a second embodiment includes an additive storage tank for storing an emulsifier that prevents the separation of water and oil when maintaining water-in-oil emulsified fuel at a high temperature; an emulsion tank having a capacity of at least a first batch raw material supply amount, and storing and mixing water-in-oil emulsified fuel; a circulation electric heater mounted to one side within the emulsion tank to uniformly maintain a temperature of the supplied water-in-oil emulsified fuel; a level switch mounted to the emulsion tank to adjust a storage amount of the water-in-oil

emulsified fuel, which is established to match a usage load of the boiler; a service tank receiving mixed water-in-oil emulsified fuel from the emulsion tank through an emulsified fuel transporting pump, which is connected to a lower end of the emulsion tank, temporarily storing the received water-in-oil emulsified fuel, and supplying the water-in-oil emulsified fuel to the boiler through a boiler supply line connected to a bottom end of the service tank; an additive supply pump connected to the additive storage tank and supplying at a predetermined amount the emulsifier stored therein to allow for mixing of the emulsifier with water and B-C oil; an additive flow meter connected to the additive supply pump and controlling an operation of the same such that the emulsifier is supplied by a predetermined supply amount; a B-C oil supply pump supplying B-C oil by a predetermined amount for mixing with water and an emulsifier; a B-C oil flow meter connected to the B-C oil supply pump and controlling an operation of the same such that the B-C oil is supplied by a predetermined supply amount; a first mixer connected both to an additive supply line that is connected to the additive flow meter and to a B-C oil supply line that is connected to the B-C oil flow meter, the first mixer mixing the B-C oil and the emulsifier; a water cutoff valve supplying water by a predetermined amount for mixing with the B-C oil and the emulsifier; a water flow meter connected to the water cutoff valve and controlling an operation of the same such that water is supplied by a predetermined supply amount; a mixing ejector connected both to a water supply line, which is connected to the water flow meter, and to the first mixer, the mixing ejector primarily uniformly mixing a raw material oil of the B-C oil and the emulsifier, and discharging a resulting mixture; a mixer pump connected to the mixing ejector and a lower end of the emulsion tank for re-mixing the raw material oil supplied from the mixing ejector and the emulsified fuel supplied from the emulsion tank; and a second mixer connected to the mixer pump for remixing the primarily mixed raw material oil and the emulsified fuel to uniformly emulsify a resulting mixture to uniform

minute particles, then supplying a result to the emulsion tank through the circulation electric heater.

The additive supply pump, the B-C oil supply pump, the water cutoff valve, the additive flow meter, the B-C oil flow meter, and the water flow meter operate when a LOW signal of the level switch of the emulsion tank is transmitted. The additive flow pump, the B-C oil supply, and the water cutoff valve, to which are connected respectively the additive flow meter, the B-C oil flow meter, and the water flow meter discontinue operation according to a discontinue signal transmitted when predetermined values of these flow meters are reached.

Further, following the supply of a predetermined amount of the raw materials, emulsified fuel mixed in a circulation system of the emulsion tank, the mixer pump, the second mixer, and the circulation electric heater is continuously circulated even if raw material supply is stopped such that emulsified fuel that is always in a uniform state is supplied while maintaining a predetermined ratio, a predetermined moisture particle state, and a predetermined temperature.

The apparatus further includes a level switch mounted in the service tank to allow for adjustment of the amount of the water-in-oil emulsified fuel, which is established to correspond to a usage load of the boiler, and the emulsified fuel transporting pump operates when a LOW signal of the level switch of the service tank is sensed, and discontinues operation when a LOW signal of a level switch of the emulsion tank is sensed.

The apparatus further includes a temperature retaining electric heater mounted to an outer circumference of the service tank such that the temperature of the water-in-oil emulsified fuel stored therein may be maintained at a predetermined temperature.

In the second embodiment, the first mixer is a single-type line mixer, and the second mixer is a double-type line mixer.

An apparatus for producing and supplying water-in-oil emulsified fuel

according to a third embodiment includes an additive storage tank for storing an emulsifier that prevents the separation of water and oil when maintaining water-in-oil emulsified fuel at a high temperature; an emulsion tank for storing water-in-oil emulsified fuel and supplying the same to a boiler from a center side area through a boiler supply line; a level switch mounted to the emulsion tank to adjust a storage amount of the water-in-oil emulsified fuel, which is established to mach a usage load of the boiler; an additive supply pump connected to the additive storage tank supplying at a predetermined amount the emulsifier stored therein to allow for mixing of the emulsifier with water and B-C oil; an additive flow meter connected to the additive supply pump and controlling an operation of the same such that the emulsifier is supplied by a predetermined supply amount; a B-C oil supply pump supplying B-C oil by a predetermined amount for mixing with water and an emulsifier; a B-C oil flow meter connected to the B-C oil supply pump and controlling an operation of the same such that the B-C oil is supplied by a predetermined supply amount; a first mixer connected both to an additive supply line that is connected to the additive flow meter and to a B-C oil supply line that is connected to the B-C oil flow meter, the first mixer mixing the B-C oil and the emulsifier; a water cutoff valve supplying water by a predetermined amount for mixing with the B-C oil and the emulsifier; a water flow meter connected to the water cutoff valve and controlling an operation of the same such that water is supplied by a predetermined supply amount; a second mixer connected to a water supply line that is connected to the water flow meter and connected to the first mixer to primarily uniformly mix water in raw material oil of the B-C oil and the emulsifier; a mixer pump connected to the second mixer and a lower end of the emulsion tank to remix raw material oil supplied from the second mixer and the emulsified fuel supplied from the emulsion tank; a circulation electric heater connected to the mixer pump for uniformly maintaining mixed raw material oil supplied therefrom at a predetermined temperature; and a third mixer connected to the circulation

electric heater for mixing raw material oil supplied therefrom and the emulsified fuel to uniformly emulsify a resulting mixture to uniform minute particles, then supplying a result to the emulsion tank.

The additive supply pump, the B-C oil supply pump, the water cutoff valve, the additive flow meter, the B-C oil flow meter, and the water flow meter operate when a LOW signal of the level switch of the emulsion tank is transmitted. The additive flow pump, the B-C oil supply pump, and the water cutoff valve, to which are connected respectively the additive flow meter, the B-C oil flow meter, and the water flow meter discontinue operation according to a discontinue signal transmitted when predetermined values of these flow meters are reached, and

Further, following the supply of a predetermined amount of the raw materials, emulsified fuel mixed in a circulation system of the emulsion tank, the mixer pump, the circulation electric heater, and the third mixer is continuously circulated even if raw material supply is stopped such that emulsified fuel that is always in a uniform state is supplied while maintaining a predetermined ratio, a predetermined moisture particle state, and a predetermined temperature.

In the third embodiment, the first mixer and the second mixer are single-type mixers, and the third mixer is a double-type mixer.

An apparatus for producing and supplying water-in-oil emulsified fuel according to a fourth embodiment includes an additive storage tank for storing an emulsifier that prevents the separation of water and oil when maintaining water-in-oil emulsified fuel at a high temperature; an emulsion tank having a capacity of at least a second batch raw material supply amount, and storing and mixing water-in-oil emulsified fuel; a level switch mounted to the emulsion tank to adjust a storage amount of the water-in-oil emulsified fuel, which is established to mach a usage load of a boiler; an additive supply pump connected to the additive storage tank supplying at a predetermined amount the emulsifier stored therein to allow for mixing of the

emulsifier with water and B-C oil; an additive flow meter connected to the additive supply pump and controlling an operation of the same such that the emulsifier is supplied by a predetermined supply amount; a B-A oil supply pump supplying B-A oil by a predetermined amount for mixing with water and an emulsifier; B-A oil flow meter connected to the B-A oil supply pump and controlling an operation of the same such that the B-A oil is supplied by a predetermined supply amount; a first mixer connected both to an additive supply line that is connected to the additive flow meter and to a B-A oil supply line that is connected to the B-A oil flow meter, the first mixer mixing the B-A oil and the emulsifier; a water cutoff valve supplying water by a predetermined amount for mixing with the B-A oil and the emulsifier; a water flow meter connected to the water cutoff valve and controlling an operation of the same such that water is supplied by a predetermined supply amount; a second mixer connected to a water supply line that is connected to the water flow meter and connected to the first mixer to primarily uniformly mix water in raw material oil of the B-A oil and the emulsifier; a mixer pump connected to the second mixer and a lower end of the emulsion tank to remix raw material oil supplied from the second mixer and the emulsified fuel supplied from the emulsion tank; and a third mixer connected to the mixer pump for mixing primarily mixed raw material oil supplied therefrom and the emulsified fuel to uniformly emulsify a resulting mixture to uniform minute particles, then supplying a result to the emulsion tank.

The additive supply pump, the B-A oil supply pump, the water cutoff valve, the additive flow meter, the B-A oil flow meter, and the water flow meter operate when a LOW signal of the level switch of the emulsion tank is transmitted. The additive flow pump, the B-A oil supply pump, and the water cutoff valve, to which are connected respectively the additive flow meter, the B-A oil flow meter, and the water flow meter, discontinue operation according to a discontinue signal transmitted when predetermined values of these flow meters are reached.

Further, following the supply of a predetermined amount of the raw materials, emulsified fuel mixed in a circulation system of the emulsion tank, the mixer pump, and the third mixer is continuously circulated even if raw material supply is stopped such that emulsified fuel that is always in a uniform state is supplied while maintaining a predetermined ratio, a predetermined moisture particle state, and a predetermined temperature.

In the apparatus for producing and supplying water-in-oil emulsified fuel of the present invention, an emulsifier and water are primarily mixed in crude oil such as B-C oil or B-A oil, then an emulsified fuel, which has undergone a second mixing process that forms very minute water-in-oil particles, is maintained at a predetermined temperature in the emulsion tank. At the same tank, the emulsified fuel circulates through the circulation system of the emulsion tank to be supplied to the boiler while being maintained in an optimum emulsion state. As a result, a combustion is not discontinued, and fuel consumption is reduced.

Further, with the emulsified fuel supplied from the apparatus of the present invention, the fuel particles combusted in the combustion chamber are made into minute particles, that is, to particle sizes roughly 10,000 smaller than with conventional fuel such that the possibility of contact with oxygen during combustion is increased, thereby ensuring significantly greater full combustion and reducing excessive oxygen concentration in the exhaust gas. Therefore, energy is saved and boiler efficiency is increased.

In addition, with the use of the apparatus of the present invention, an air pollution reduction device such as dust collecting equipment is unneeded, and overall equipment operation costs such as power costs and maintenance are reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a structural view of an apparatus for producing and supplying water-in-oil emulsified fuel according to a first embodiment of the

present invention.

FIG. 2 is a sectional view of a single-type line mixture applied to an apparatus for producing and supplying water-in-oil emulsified fuel according to a first embodiment of the present invention.

FIG. 3 is a sectional view of a mixing ejector applied to an apparatus for producing and supplying water-in-oil emulsified fuel according to a first embodiment of the present invention.

FIG. 4 is a sectional view of a double-type line mixer applied to an apparatus for producing and supplying water-in-oil emulsified fuel according to a first embodiment of the present invention.

FIG. 5 is a structural view of an apparatus for producing and supplying water-in-oil emulsified fuel according to a second embodiment of the present invention.

FIG. 6 is a structural view of an apparatus for producing and supplying water-in-oil emulsified fuel according to a third embodiment of the present invention.

FIG. 7 is an apparatus for producing and supplying water-in-oil emulsified fuel according to a fourth embodiment of the present invention.

DETAILED DESCRIPTION

Embodiments of the present invention will now be described in detail with reference to the accompanying drawings.

FIG. 1 is a structural view of an apparatus for producing and supplying water-in-oil emulsified fuel according to a first embodiment of the present invention.

With reference to FIG. 1, an apparatus 10 for producing and supplying water-in-oil emulsified fuel includes an additive storage tank 20 for storing an emulsifier; an emulsion tank 30 for storing water-in-oil emulsified fuel; a raw material supplier for supplying at a predetermined ratio and according to predetermined values B-C oil, an emulsifier, and water, which

become the raw materials for water-in-oil emulsified fuel; a first mixing section for consecutively and uniformly mixing the supplied raw materials; and a second mixing section for mixing the primarily mixed raw material oil with pre-emulsified fuel to perform emulsion.

The emulsifier stored in the additive storage tank 20 is an additive that acts to prevent the separation of water and oil when a high temperature state of the water-in-oil emulsified fuel is maintained.

Glass wool is provided to an exterior of the additive storage tank 20 to insulate the same and maintain a constant temperature. Further, a level gauge 19 is attached to the tank 20 to sense a storage amount of the emulsifier. A steam coil 22 is mounted to an inner surface of the additive storage tank 20 to maintain the stored emulsifier at a temperature of 60~110℃. Also, an electric heater 24 is mounted to a lower output side of the additive storage tank 20 to uniformly maintain the emulsifier exiting the tank 20 at a temperature of 60~110℃. As a result, the emulsifier exits an additive supply pump 21 at a fixed rate. The additive supply pump 21 will be described below.

The emulsion tank 30 stores water-in-oil emulsified fuel, and, at the same time, performs the function of a service tank that supplies the fuel to a boiler (not shown). Such supply of the water-in-oil emulsified fuel is realized through a boiler supply line Lb, which is formed from a lower, side portion of the emulsion tank 30.

A level switch 34 for adjusting a storage amount of the water-in-oil emulsified fuel, which is established to match a usage load of the boiler, is mounted to the emulsion tank 30. The level switch 34 senses a HIGH or a LOW level depending on the storage amount of the water-in-oil emulsified fuel in the emulsion tank 30, and at the moment the storage amount of the water-in-oil emulsified fuel reaches a first batch raw material supply amount, operates a low level switch 34b to transmit an operational signal to a fuel supply section. On the other hand, at the moment the storage amount of the

water-in-oil emulsified fuel reaches a second batch raw material supply amount, the level switch 34 operates a high level switch 34a to transmit a stop signal to the fuel supply section.

Here, the first batch raw material supply amount refers to a total amount of raw material (B-C oil, emulsifier, water) that is continuously supplied during a first supply time.

Accordingly, it is preferable that the emulsion tank 30 is manufactured having a capacity of at least a two batch raw material supply amount.

A circulation electric heater 32 is mounted adjacent to an inner surface of the emulsion tank 30. The circulation electric heater 32 provides sufficient heat to water-in-oil emulsified fuel, which is at a low temperature, newly mixed, and supplied to the emulsion tank 30, such that the fuel is maintained at a temperature of 60~80℃ to thereby minimize a temperature difference within the emulsion tank 30. A structure of the circulation electric heater 32 is realized through a shell and tube heat exchanger such that a heat exchange speed is increased. Further, to enable each temperature control, a reducer nozzle is used at an exit according to the flow amount, and an angle of the nozzle is set at 45° to be directed toward an entrance of mixer pumps 28a and 28b, which will be explained below, to thereby create a vortex so that heat circulation of the water-in-oil emulsified fuel is made smooth, and uniformly mixed particles are first raised to an upper level such that outflow occurs starting with stable particles.

A temperature retaining electric heater 31 is mounted to an exterior of the emulsion tank 30. The temperature retaining electric heater 31 senses the temperature of the stored water-in-oil emulsified fuel and maintains the temperature at a predetermined temperature within the range of 60~80℃. Although the heat temperature retaining electric heater 31 undergoes operation linked with the circulation electric heater 32 during an emulsion

mixing operation, in the case where the temperature retaining electric heater 31 is stopped for a long duration of time following completion of one operation and before the next operation, the linking is severed and the temperature retaining electric heater 31 operates independently to maintain the emulsion tank at a constant temperature.

The raw material supplier includes pumps and flow meters to supply each of an emulsifier, B-C oil, and water uniformly and according to predetermined values.

First, to supply the emulsifier, there are provided the additive supply pump 21 and an additive flow meter 23. The additive supply pump 21 is connected to an output of the additive storage tank 20, and operates after receiving a LOW signal of the level switch 34 of the emulsion tank 30 to supply an emulsifier at a fixed ratio of 0.5~1% of the first batch raw material supply amount. The additive supply pump 21 discontinues operation when receiving a stop signal from the additive flow meter 23. When receiving the stop signal, the additive supply pump 21 blocks the pipe to thereby act as an additive supply line stop valve.

The additive flow meter 23 is connected to the additive supply pump 21 and controls the same such that an emulsifier is supplied according to an emulsifier adding predetermined value. That is, the additive flow meter 23 operates when detecting a LOW signal of the level switch 34 of the emulsion tank 30. Following the supply of an emulsifier to a predetermined supply amount, the additive flow meter 23 transmits a stop signal to the additive supply pump 21 so that the same discontinues operation.

In order to supply B-C oil, there are provided a B-C oil supply pump 12 and a B-C oil flow meter 14. The B-C oil supply pump 12 operates when detecting a LOW signal of the level switch 34 of the emulsion tank 30 to supply B-C oil at a fixed ratio of 69.5~89.5% of the first batch raw material supply amount. The B-C oil supply pump 12 discontinues operation when receiving a stop signal from the B-C oil flow meter 14. This signal

transmission is realized through a control panel (not shown).

The B-C oil flow meter 14 is connected to the B-C oil supply pump 12 and controls the same such that B-C oil is supplied according to a predetermined B-C oil supply amount. That is, the B-C oil flow meter 14 operates when detecting a LOW signal of the level switch 34 of the emulsion tank 30. Following the supply of B-C oil to the predetermined supply amount, the B-C flow meter 14 transmits a stop signal to the B-C oil supply pump 12 so that the same discontinues operation.

In order to supply water, there are provided a water cutoff valve 16 and a water flow meter 18. The water cutoff valve 16 operates when detecting a LOW signal of the level switch 34 of the emulsion tank 30 to supply water at a fixed ratio of 10~30% of the first batch raw material supply amount. The water cutoff valve 16 discontinues operation when receiving a stop signal from the water flow meter 18. This signal transmission is realized through a control panel (not shown).

The water flow meter 18 is connected to the water cutoff valve 16 and controls the same such that water is supplied according to a predetermined water supply amount. That is, the water flow meter 18 operates when detecting a LOW signal of the level switch 34 of the emulsion tank 30. Following the supply of water to the predetermined supply amount, the water flow meter 18 transmits a stop signal to the water cutoff valve 16 to thereby discontinue the supply of water.

During the supply of raw materials, the first mixing section, which performs an initial pre-mix function and maximizes the efficiency of the second mixing section, includes a first mixer 25 and a mixing ejector 27.

An additive supply line La connected to the additive flow meter 23 and a B-C oil supply line Lo connected to the B-C oil flow meter 14 are both connected to the first mixer 25 such that B-C oil and an emulsifier are mixed. With reference to FIG. 2, preferably a single-type (S-type) line mixer is used for the first mixer 25.

A water supply line Lw and the first mixer 25 are connected to the mixing ejector 27 such that water is mixed with the raw materials that contain an emulsifier. The mixing ejector 27, with reference to FIG. 3, utilizes a method of performing mixing by inserting a secondary supply pipe in a venturi pipe, which is a pipe having enlarged and reduced inner diameter.

The second mixing section performs the function mixing to minute particles the first raw material oil, which is uniformly mixed in the first mixing section, and includes a mixer pump 28 and a second mixer 29.

The mixer pump 28 is connected to both the mixing ejector 27 and a lower end of the emulsion tank 3, and re-mixes raw material oil supplied from the mixing ejector 27 and emulsified fuel supplied from the emulsion tank 30. The mixer pump 28 undergoes continuous operation while the apparatus of the embodiment of the present invention is driven, and it is preferable that the mixer pump 28 has a capacity to enable mixing of the entire emulsified fuel capacity stored in the emulsion tank 30 during the time it takes for a combustion apparatus to consume one batch. Further, the mixer pump 28 includes a pre-mixer pump 28b and a main mixer pump 28a, which are connected in parallel between the emulsion tank 30 and the second mixer 29, to thereby allow provisions against states of emergency and for repair of the apparatus.

The second mixer 29 is connected to the mixer pump 28 such that water-in-oil emulsified fuel, in which raw material oil that undergoes primary mixing is emulsified to uniform minute particles, is supplied to the emulsion tank 30 through the circulation electric heater 32. For the second mixer 29, with reference to FIG. 4, a double-type (D-type) line mixer is preferably used. A capacity of the second mixer 29 is at least two times the first batch raw material supply amount, and the raw material oil that undergoes primary mixing and the emulsified fuel ideally mixed in the emulsion tank 30 are each supplied at approximately 20~50% to undergo secondary mixing, thereby maximizing a water ratio and particle stability.

An operation of the apparatus according to the first embodiment of the present invention will now be described.

The basic operation of the apparatus 10 for producing and supplying water-in-oil emulsified fuel will now be described.

The apparatus 10 for producing and supplying water-in-oil emulsified fuel operates as a system that replenishes and supplies an emulsified fuel to the emulsion tank 30 according to a load amount of a boiler (not shown) while retaining a predetermined amount of fuel in the emulsion tank 30.

In a normal operating state, operation begins at or above a low level of the emulsion tank 30. The level switch 34 senses a low level and transmits a LOW signal while fuel is being consumed by the operation of the boiler.

A signal is sent to the raw material supplier from the control panel (not shown), which receives the transmitted LOW signal, such that the additive supply pump 21 and the B-C oil supply pump 12 are operated, and the water cutoff valve 16 is opened, thereby performing first batch driving. In first batch driving, an emulsifier, B-C oil, and water are supplied for a predetermined duration of time and at a predetermined ratio.

With the operation of the additive supply pump 21 and the B-C oil supply pump 12, the emulsifier and the B-C oil supplied respectively therefrom are mixed in the first mixer 25. Also, water is supplied with the opening of the water cutoff valve 16, and this supplied water is mixed with the fuel of mixed emulsifier and B-C oil in the mixing ejector 27.

The raw materials, in a state where they are all mixed, are supplied to the mixer pump 28, and emulsified fuel that is pre-mixed to 20~50% of the raw material oil is supplied to the mixer pump 28 from the emulsion tank 30 and mixed with the raw material oil in the intake side.

The raw material oil mixed as described above is sent to the second mixer 29 by the mixer pump 28, and the oil is mixed to an emulsified state having uniform particles in the second mixer 29 and transmitted to the emulsion tank 30.

If the temperature of the emulsion tank 30 is at or below a predetermined temperature as a result of the temperature of the emulsified fuel being low when supplied to the emulsion tank 30, the circulation electric heater 32 is turned On to raise the temperature of the emulsified fuel before supply. When the temperature of the emulsion tank is at or above a predetermined temperature, the power to the electric heater 32 is turned Off.

With regard to the flow rate determined for the first batch operation, if supply completion is determined by each of the flow meters, the power to each pump is turned Off by the signals of the flow meters that discontinue supply. That is, if the predetermined amount of the B-C oil is supplied from the B-C oil flow meter 14, power to the B-C oil supply pump 12 is turned Off after this is sensed in the control panel. Also, if the predetermined amount of the emulsifier is supplied from the additive flow meter 23, power to the additive supply pump 21 is turned Off after this is sensed in the control panel. Finally, if the predetermined amount of the water is supplied from the water flow meter 18, the water cutoff valve 16 is closed after this is sensed in the control panel, thereby discontinuing the supply of water.

After the supply of the first batch raw material, the amount of the emulsified fuel in the emulsion tank 30 is reduced to at or below the second batch raw material supply amount. Also, the emulsified fuel in the emulsion tank 30 is circulated through the mixer pump 28 and the second mixer 29 so that continuous mixing is realized until emulsified fuel of as much as the first batch raw material supply amount is consumed depending on the boiler usage load.

If the low level switch 34 is operated as a result of the continuous consumption of the emulsified fuel depending on the boiler fuel usage amount, the above process is repeated so that emulsified fuel is replenished.

FIG. 5 is a structural view of an apparatus for producing and supplying water-in-oil emulsified fuel according to a second embodiment of the present invention.

With reference to FIG. 5, an apparatus 40 for producing and supplying water-in-oil emulsified fuel includes an additive storage tank 41 for storing an emulsifier; an emulsion tank 43 for storing water-in-oil emulsified fuel; a raw material supplier for supplying at a predetermined ratio and according to predetermined values B-C oil, an emulsifier, and water, which become the raw materials for water-in-oil emulsified fuel; a first mixing section for consecutively and uniformly mixing the supplied raw materials; and a second mixing section for mixing the primarily mixed raw material oil with pre-emulsified fuel to perform emulsion. The apparatus also includes a service tank 45 that stores water-in-oil emulsified fuel before the same is supplied to a boiler.

It is preferable that the emulsion tank 43 is manufactured having a capacity of at least a two batch raw material supply amount.

The service tank 45 receives the mixed water-in-oil emulsified fuel from the emulsion tank 43 through an emulsified fuel transporting pump 47, which is connected to a lower end of the emulsion tank 43. The service tank 45 temporarily stores the received water-in-oil emulsion tank 43, then supplies the same to the boiler through a boiler supply line Lb connected to a bottom end of the service tank 45.

A level switch 49 is mounted in the service tank 45 to allow for adjustment of the amount of the water-in-oil emulsified fuel, which is established to correspond to a usage load of the boiler. That is, the emulsified fuel transporting pump 47 operates when a LOW signal of the level switch 49 of the service tank 45 is sensed, and discontinues operation when a LOW signal of a level switch 46 of the emulsion tank 43 is sensed.

A temperature retaining electric heater 48 is mounted to an outer circumference of the service tank 45 such that the temperature of the water-in-oil emulsified fuel stored therein may be maintained at a predetermined temperature.

The configuration and operation of all other structural elements of

the apparatus 40 for producing and supplying water-in-oil emulsified fuel according to the second embodiment are identical to or fall within the same scope as the first embodiment.

FIG. 6 is a structural view of an apparatus for producing and supplying water-in-oil emulsified fuel according to a third embodiment of the present invention.

With reference to FIG. 6, an apparatus 60 for producing and supplying water-in-oil emulsified fuel includes an additive storage tank 61 for storing an emulsifier; an emulsion tank 63 for storing water-in-oil emulsified fuel; a raw material supplier for supplying at a predetermined ratio and according to predetermined values B-C oil, an emulsifier, and water, which become the raw materials for water-in-oil emulsified fuel; a first mixing section for consecutively and uniformly mixing the supplied raw materials; and a second mixing section for mixing the primarily mixed raw material oil with pre-emulsified fuel to perform emulsion.

In the apparatus 60 for producing and supplying water-in-oil emulsified fuel according to the third embodiment, a circulation electric heater 70 and a third mixer 69 are mounted in this sequence on a circulation line that extends from a mixer pump 68 to the emulsion tank 63. Accordingly, raw material oil mixed in the mixer pump 68 uniformly absorbs heat of a predetermined temperature in the circulation electric heater 70 and is supplied to the third mixer 69. After this raw material oil is emulsified in the third mixer 69 to uniform and minute particles, it is supplied to the emulsion tank 63.

Further, in the apparatus 60 according to the third embodiment, a single-type mixer is used for a first mixer 65, where an additive supply line La and a B-C oil supply line Lo meet to mix an emulsifier and B-C oil, and a single-type mixer is used for a second mixer 67, where raw material oil mixed in the first mixer 65 and water supplied from a water supply line Lw are mixed. A double-type mixer is used for a third mixer 69 that emulsifies mixed

raw material oil.

The configuration and operation of all other structural elements of the apparatus 60 for producing and supplying water-in-oil emulsified fuel according to the third embodiment are identical to or fall within the same scope as the first embodiment.

FIG. 7 is an apparatus for producing and supplying water-in-oil emulsified fuel according to a fourth embodiment of the present invention.

With reference to FIG. 7, an apparatus 80 for producing and supplying water-in-oil emulsified fuel includes an additive storage tank 81 for storing an emulsifier; an emulsion tank 83 for storing water-in-oil emulsified fuel; a raw material supplier for supplying at a predetermined ratio and according to predetermined values B-C oil, an emulsifier, and water, which become the raw materials for water-in-oil emulsified fuel; a first mixing section for consecutively and uniformly mixing the supplied raw materials; and a second mixing section for mixing the primarily mixed raw material oil with pre-emulsified fuel to perform emulsion.

In the apparatus 80 according to the third embodiment, a mixing ejector and a single-type mixer are used for a first mixer 84, where an additive supply line La and a B-C oil supply line Lo meet to mix an emulsifier and B-C oil, and for a second mixer 86, where raw material oil mixed in the first mixer 84 and water supplied from a water supply line Lw are mixed. A double-type mixer is used for a third mixer 88 that emulsifies mixed raw material oil.

With respect to the third mixer 88, raw material oil supplied from a mixer pump 85 is emulsified therein to uniform and minute particles, then supplied directly to the emulsion tank 83.

The configuration and operation of all other structural elements of the apparatus 80 for producing and supplying water-in-oil emulsified fuel according to the fourth embodiment are identical to or fall within the same scope as the first embodiment.

Although embodiments of the present invention have been described in detail hereinabove, it should be clearly understood that many variations and/or modifications of the basic inventive concepts herein taught which may appear to those skilled in the present art will still fall within the spirit and scope of the present invention, as defined in the appended claims.